

## COMPLEX MOTION TOOTHBRUSH

### CROSS REFERENCES TO RELATED APPLICATIONS

5        This is a continuation of Application No. 10/367,373, filed February 13, 2003, which is a continuation of Application No. 09/993,167, filed November 6, 2001, the substances of which are incorporated herein by reference.

### FIELD OF THE INVENTION

10      The invention is related to the art of electric toothbrushes and detachable heads therefor.

### BACKGROUND OF THE INVENTION

15      Electric toothbrushes having one or more bristle holders are known in the art. However, there is a continuing need to provide electric toothbrushes which can provide improved cleaning by a synergistic combination of a first bristle holder motion and the bristle tuft arrangements of the first and/or second bristle holders.

### BRIEF SUMMARY OF THE INVENTION

20      A detachable head for use with an electric toothbrush is provided. The electric toothbrush has a handle with a motor disposed therein that is operatively connected to a shaft. The detachable head has an elongate body with a longitudinal axis and a first end and a second end opposite said first end. The first end may be detachably coupled to the electric toothbrush. The detachable head has a first bristle holder with a first plurality of bristle tufts disposed thereon. The first bristle holder is located at the second end of the elongate body and can oscillate about an axis substantially perpendicular to the longitudinal axis. The detachable head also has a second bristle holder disposed between the first bristle holder and the first end. The second bristle holder has a top surface and a second plurality of bristle tufts that form an acute angle with the top surface 25 of the second bristle holder.

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### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The invention may take form in various components and arrangements of components, and in various procedures and arrangements of procedures. The drawings

are only for purposes of illustrating preferred embodiments, they are not to scale, and not to be construed as limiting the invention.

FIG. 1 is a sectional bottom view of a toothbrush.

FIG. 2 shows a cross-sectional side view of part of the toothbrush of FIG. 1.

5 FIG. 3 is a sectional bottom view of FIG. 2.

FIG. 4 is an opposite side view of FIG. 2.

FIGS. 5, 6 and 7 are respectively the same views as FIGS. 2, 3 and 4 of a different toothbrush and to a different scale.

FIG. 8 is a bottom view of an enhanced toothbrush having a second bristle holder.

10 The toothbrush is shown in partial section.

FIG. 9 is a sectional view taken along A-A in FIG. 8 of a first embodiment of a toothbrush head portion.

FIG. 9A is a partial sectional side view of the first embodiment.

15 FIG. 10 is a sectional view taken along A-A in FIG. 8 of a second embodiment of a toothbrush head portion.

FIG. 11 is a sectional view taken along A-A in FIG. 8 of a third embodiment of a toothbrush head portion.

FIG. 12 is a partial sectional view taken along B-B in FIG. 8 of a fourth embodiment of a toothbrush head.

20 FIG. 13 is a partial sectional view taken along B-B in FIG. 8 of a fifth embodiment of a toothbrush head.

FIG. 14 is a partial sectional view taken along B-B in FIG. 8 of the fifth embodiment of a toothbrush head. A shaft is shown rotated to a different position than shown in FIG. 13.

25 FIG. 15 is a partial sectional view taken along B-B in FIG. 8 of a sixth embodiment of a toothbrush head.

FIG. 16 is a partial sectional view taken along B-B in FIG. 8 of a seventh embodiment of a toothbrush head.

FIG. 17 is a bottom view of a head portion of a ninth embodiment of a toothbrush.

30 FIG. 18 is a partial sectional view taken along B-B in FIG. 8 of the ninth embodiment of a toothbrush head.

FIG. 19 is a partial sectional view taken along B-B in FIG. 8 of a tenth

embodiment of a toothbrush head.

FIG. 20 is a side view of a toothbrush showing a first exemplary alternate bristle arrangement.

FIG. 21 is an end view taken along D-D of FIG. 8 showing a second exemplary 5 bristle arrangement.

FIG. 22 is a partial sectional view taken along B-B in FIG. 8 of a second implementation of the fifth embodiment showing an alternate cam design.

#### DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings, in FIG. 1 the toothbrush comprises a handle **10** at a first end of the toothbrush, a head **11** at a second end of the toothbrush, a neck **9** extending therebetween, a rotatable shaft **12** extending from the handle to the head, and a generally circular bristle holder **13** having a plurality of bristle tufts embedded therein, wherein each tuft **8** comprises a plurality of bristles. The handle provides compartments for holding an electric motor **14** and two batteries **15** and **16**, although a rechargeable power source can be substituted for the batteries **15** and **16**. A shaft coupling **17** is arranged to grip one end of the shaft **12** and allow the shaft to be pulled out for cleaning or replacement as will be described below.

The head **11**, as is better seen in FIG. 2, supports a post **18**, which provides a 20 rotational or oscillatory pivot axis **40** for the bristle holder **13**. Bristles **19** are shown for illustrative purposes only in FIG. 2. The shaft **12** has an integrally formed remote-most end **20** that is offset from a central longitudinal axis **21** of the shaft. The remote-most end **20** fits into a slot **22** (see FIG. 3) formed in a side of the bristle holder **13**. It will be noted that the end **20** points towards an intersection of the first axis **21** and the pivot axis **40** of the post **18**. In one embodiment, the post is arranged so that the pivot axis **40** is substantially perpendicular to the central longitudinal axis **21** of the shaft. The pivot axis **40** is also substantially parallel to the direction in which the bristles **19** extend. While this arrangement is preferred, it is contemplated that the post **18** can be arranged differently. For example, the post **18** might be angled so that the pivot axis **40** is not 25 substantially perpendicular to the longitudinal axis **21** of the shaft but rather forms an acute angle therewith in order to provide a wobbling or swiveling action about the pivot axis **40**. When the shaft **12** is rotated by the motor **14**, the remote end **20** describes a

circle about the shaft 12 and drivingly engages the slot 22 to cause the bristle holder 13 to vibrate or oscillate about the pivot axis of the bristle holder 13. In this regard, the formed remote-most end 20 may be considered to be a cam or a gear tooth. To vibrate is to move to and fro or from side to side. To oscillate is to move or travel back and forth between two points. A cam is a shaped component or potion of a component, which determines the motion of a follower. As may be seen in FIG. 3, slot 22 is closed-ended and extends radially inward from the outer circumference of the holder to less than the distance to the center of the holder and between adjacent pairs of bristle holes. Thus, the bristle holder 13 pivots, oscillates, or rotates forwards and backwards about the center of the post 18.

To pivot is to turn on or as if on a pivot. To rotate is to turn about an axis or a center. Such movement provides a first relative motion between the head 11 and the bristles 19 and is generally beneficial for efficient cleaning of teeth. The width of the slot 22 is preferably generally the same as the diameter of the end 20 to leave minimum play; this keeps noise to a minimum in use.

Preferably, the motor 14 runs at around 6000 rpm. Where desired, the motor can run at other speeds or be arranged to run at two or more speeds, selectable by the user. FIG. 1 shows a toothbrush where the holder 13 vibrates, oscillates, or rotates through an angle of 30 degrees. In FIG. 2, the angle is 35 degrees and in FIG. 5 the angle is 15 degrees. It will therefore be appreciated that the rotational angle can be chosen by fitting different shafts 12 and that the same bristle holder can be used for all angles.

Each bristle holder 13 may be provided with more than one slot 22 as may be seen in FIG. 3, opposite each other so as to be better balanced or so that different slots can be used if the one slot wears or if the bristles wear unevenly in use. In other words, the holder 13 can then be set up in two or more rotational positions. The holder 13 is preferable easily removable from the head 11, by being spring clipped to the post 18 for example. Such removal allows better cleaning and storing in a hygienic container perhaps and also enables the shaft 12 to be readily withdrawn and replaced when required.

The described shafts 12 are preferably integrally formed, i.e., a single length of a thin rod and shaped as shown. However, it is possible to arrange for the remote end or can 20 to be separately formed or provided and fixed to a straight end part of the shaft or elsewhere on the shaft. Such a separate part can be a brush having a central axis

coinciding with the axis **21** of the shaft and an off-center driving post. The driving post then takes up the position and function of the remote end or cam **20**. Thus, the driving post and the slot **22** then form the driving engagement between the shaft and the holder **13** and so the driving post can be regarded as the remote end of the shaft.

5 It is also possible, but not usually so convenient, in some embodiments of the invention to arrange for the holder **13** to be hingedly pivoted at one side, for example opposite the shaft. In such a case, bristles mounted nearer the hinged pivot will not actually move as much as bristles at the side next to the shaft but they will still vibrate significantly.

10 It will also be appreciated that whether pivoted to rotate or to hinge, the bristle holder **13** need not be circular. However, a circular holder **13** is normally preferred so that its rotational position can be changed when desired, as mentioned above.

15 While the above-described shaft arrangement is preferred, it is contemplated that other shaft arrangements can be used with the present invention. For example, the arrangement described in U.S. Patent No. 5,732,432, the substance of which is incorporated herein by reference, might be substituted to accommodate mechanical misalignments of the shaft and mechanical strain during use. Further, the head **11** might be provided in a form in which it can be readily detached from the handle **10**. This could be accomplished using, coupling arrangements for the shaft and body portion of the head.  
20 Such arrangements are known in the art. For example, the head and handle portions can include mating slots, spring clips, and protrusions and/or locking or securing tabs and grooves. The shaft can be divided into two sections, each section including a coupling element. For example the coupling is achieved with a keyed arrangement. For instance, coupling elements can include male and female mating splines affixed to respective shaft  
25 section ends, or as shown in U.S. Patent No. 5,617,601, the substance of which is incorporated herein by reference. Further, the slot **22** might be replaced by a wobble plate, such as described in U.S. Patent No. 5,784,743, the substance of which is incorporated herein by reference.

With additional reference now to FIG. 8 - FIG 18, embodiments of an enhanced  
30 electric toothbrush **810** include a first bristle holder **814** similar to the bristle holder **13** described above. The enhanced toothbrush **810** has a head **816** and a body or handle **817**. Of course, the enhanced toothbrush includes a motor **819** and batteries for powering the

motor. The head portion **816** has a longitudinal axis **818**. The first bristle holder **814** is illustrated as circular. However, other shape bristle holders are contemplated and within the scope of the invention. The first bristle holder **814** includes at least one slot as described above (see FIG. 3) for receiving a remote-most end or cam of a driving shaft **820** as described in reference to FIG. 1 - FIG. 7. The remote-most end (see FIG. 3) of the driving shaft is bent or offset from a central longitudinal axis **21** (see FIG. 3) of the driving shaft **820** as described above. The motor **819** is operative to rotate the shaft **820**. In short, with regard to the construction and operation of the shaft **820** in relation to the first bristle holder **814**, the enhanced toothbrush **810** is similar to the toothbrush described in reference to FIG. 1 - FIG. 7. However, embodiments of the enhanced electric toothbrush **810** also include second bristle holders disposed adjacent the first bristle holders, such as second bristle holder **822**. While it is desirable to locate the second bristle holder directly adjacent the first bristle holder, it is contemplated that a gap may be provided between the first and second bristle holders. In addition, the space between the movable first and second bristle holders might be filled with stationary or fixed bristles which are embedded in fixed or stationary third bristle holder (not shown) which forms part of the toothbrush head. In many embodiments of the enhanced electric toothbrush, the second bristle holders are movable and separately associated with, and separately driven by, a driving shaft such as the driving shaft **820**. The movable second bristle holders are movable in directions and/or manners that are different and distinct from whichever of the rotary or hingedly pivoted vibratory movements, described in reference to FIG. 1 - FIG. 7, is used in the particular embodiment.

For example, referring to FIG. 9, a second bristle holder **910** is movably mounted in slots **912** in the toothbrush head **816** and separately driven in a vibratory, side-to-side, motion in a direction substantially perpendicular to the direction of the longitudinal axis **818** by an eccentric cam **914** included on a driving shaft **918**. The cam **914** and other cams described below can comprise one or more bends in the shaft **918**, as shown for example, example in FIG. 9A and as seen in views of other embodiments described below such as seen in FIG. 12, FIG. 13, and FIG. 15. Alternatively, the cam **914** can be provided as a separate piece, which is attached to the shaft **918** by adhesive, a press or snap fit, a co-molding or any other mechanical or chemical means known in the art.

Optionally, the driving shaft is supported by a shaft support 920. A cam follower 922 depends from a bottom surface 924 of the second bristle holder 910. The cam follower 922 is offset from a longitudinal axis 926 of the second bristle holder. As the motor 819 of the enhanced toothbrush 810 rotates the shaft 918, the cam 914 comes into contact with 5 a cam contact surface 928 of the cam follower 922 and drives the cam follower 922, and therefore, the second bristle 910 holder toward one side 930 of the enhanced toothbrush 810 and away from the longitudinal axis 818 of the head portion 816. As the shaft 918 continues to rotate, the cam 914 becomes disengaged with the cam follower 922. A resilient biasing member such as a spring 934, lodged between a wall of the head portion 10 816 and a second surface of the cam follower, urges the cam follower 922, and therefore the second bristle holder 910, back toward the longitudinal axis 818 of the head portion 816. As this back and forth or sided to side motion is repeated (as the shaft 918 continues to rotate), a sweeping or brushing motion is provided that is distinct from and complimentary to the motion provided by the first bristle holder 814. The stroke and/or 15 frequency of the second bristle holder 910 can be changed by varying the construction of the spring and placement and/or sizing of the cam 914 and the cam follower 922. For example, the cam follower 922 might be placed closer to the axis 926 to provide a shorter stroke for the cam follower 922, or a stronger spring might be provided to increase the rate of return of the second bristle holder 910 or more than one spring might be provided. 20 Alternatively, the cam follower 922 might form an acute angle with the bottom surface 924 of the second bristle holder 910 or the first surface can be provided as accurate, curvilinear, or in other complex forms as opposed to the planar surface shown in Fig. 9.

Referring to FIG. 10, in a second embodiment of the enhanced toothbrush 810 a 25 second bristle holder 1010 is movably mounted in slots 1012 in the toothbrush head 816 and separately driven in a vibratory, swinging or pivoting motion about a hinge or pivot 1014, by a cam 1016 included on a driving shaft 1018. The cam 1016 can comprise one or more bends in the shaft 1018 or be provided as a separate piece as previously discussed. Optionally, the driving shaft is supported by a shaft support 1020. A cam 30 contact surface 1022 is located on a bottom surface of the second bristle holder 1010. As the motor 819 of the enhanced toothbrush 810 rotates the shaft 1018, the cam 1016 comes into contact with the cam contact surface 1022 and drives or pushes the second bristle

holder **1010** causing the second bristle holder to swing or pivot about the hinge or pivot **1014**. As the shaft **1018** continues to rotate, the cam **1016** becomes disengaged with the cam contact surface **1022**. During use, as the cam **1016** comes in contact with the cam contact surface **1022**, bristles of the second bristle holder **1010** are urged against the users teeth with greater force. Preferably, bristles of the second bristle holder **1010** are urged between the teeth of the user to provide a cleaning and flossing function.. As the cam disengages with the contact surface **1022**, bristles pressing against the teeth of the user urge the second bristle holder away from the users teeth. As this swinging or pivoting motion is repeated (as the shaft **1018** continues to rotate), a flossing or deep cleaning motion is provided that is distinct from and complimentary to the motion provided by the first bristle holder **814**.

Referring to Figure 11, in a third embodiment of the enhanced toothbrush **810** a second bristle holder **1110** is movably mounted in slots **1112** in the toothbrush head **816** and separately driven in a vibratory, lifting or vertical pulsating motion (e.g., in a direction substantially perpendicular to the longitudinal axis **1114** and substantially parallel to a surface **1115** of the second bristle holder **1110** as shown by the way of example in Fig. 11) within the slots **1112**, by a cam **1116** included on a driving shaft **1118**. Optionally, the driving shaft is supported by a shaft support **1120**. The cam **1116** can comprise one or more bends in the shaft **1118** or can be provided as a separate piece as previously discussed. A cam contact surface **1122** is located on a bottom surface of the second bristle holder **1110**. As the motor **819** (see FIG. 8) of the enhanced toothbrush **810** rotates the shaft **1118**, the cam **1116** comes into contact with the cam contact surface **1122** and drives or lifts, in a vibratory, lifting, or vertical pulsating motion, the second bristle holder **1110** causing the second bristle holder to lift or pulsate in a direction away from the head portion **816** and toward the teeth of a toothbrush user (not shown). As the shaft **118** continues to rotate, the cam **1116** becomes disengaged with the cam contact surface **1122**. During use, as the cam **1016** comes in contact with the cam contact surface **1122**, bristles of the second bristle holder **1110** are urged against the users teeth with varying degrees of force. Preferably, bristles of the second bristle holder **1110** are urged between the teeth of the user to provide a cleaning and flossing function. As the cam disengages with the contact surface **1122**, bristles pressing against the teeth of the user urge the second bristle holder away from the users

teeth and back toward the head portion **816**. As this lifting or vertical pulsating motion is repeated (as the shaft **1018** continues to rotate), a flossing or deep cleaning motion is provided that is distinct from and complimentary to the motion provided by the first bristle holder **814**.

Referring to Figure 12, in a fourth embodiment of the enhanced toothbrush **810** a second bristle holder **1210** is movably mounted in slots (not shown, but similar to the slots **912** illustrated in Fig. 9) in the toothbrush head **816** and separately driven in a reciprocating or translating, longitudinal motion within the slots by a cam **1216** included on a driving shaft **1218**. Optionally, the shaft is supported by shaft supports **1217**. The shaft supports may include C or U shaped portions (not shown) that are operative to receive and snap around the shaft. Other means for retaining a shaft in a support are known in the art. The cam **1216** can comprise a shaped bead, with an appropriate eccentric configuration, placed or molded over and firmly secured to the shaft **1218**. In one embodiment, the cam **1216** includes a pair of acutely angled surfaces **1219**, **1220** which are inclined in the same direction and at the same angle of inclination, but which are disposed at opposite ends of the cam **1216**. The direction of inclination and angle of inclination can be varied as desired to change the frequency and stroke of the second bristle holder **1210**. First **1222** and second **1226** cam followers depend from a bottom surface of the second bristle holder **1210**. The cam followers **1222**, **1226** are offset or spaced from a transverse axis **1230** of the second bristle holder. The cam followers **1222**, **1226** straddle and/or capture the cam **1216** so that the angled surfaces **1219**, **1220** slidably engage the free ends of the cam followers **1222** and **1226**. As the motor **819** (see FIG. 8) of the enhanced toothbrush **810** rotates the shaft **1218**, the first acutely angled surface **1220** of the cam **1216** comes into contact with a surface of the first cam follower **1222** and drives the cam follower, and therefore, the second bristle holder **1210**, away from the first bristle holder **814** along the longitudinal axis **818** of the head portion **816**. As the shaft **918** continues to rotate, the cam **1216** becomes disengaged with the first cam follower **1222**. The second acutely angled second surface **1219** of the cam **1216** then comes into contact with a surface of the second cam follower **1226** and drives the second cam follower **1226**, and therefore, the second bristle holder **1210**, back toward the first bristle holder **814**. As this back and forth motion is repeated (as the shaft **918** continues to rotate), a scrubbing action is provided by the reciprocating or translating motion that is

distinct from and complimentary to the motion provided by the first bristle holder **814**.

Referring to FIG. 13 and FIG. 14, in a fifth embodiment of the enhanced toothbrush **810** a second bristle holder **1310** is movably mounted in slots (not shown, but similar to the slots **912** illustrated in Fig. 9) in the toothbrush head **816** and separately driven in an reciprocating or translating, longitudinal motion, by a cam **1316** included on a driving shaft **1318**. Optionally, the shaft is supported by shaft supports **1317**. The shaft supports may include C or U shaped portions (not shown) that are operative to receive and snap around the shaft. Other means for retaining a shaft in a support are known in the art. The cam **1316** is sinusoidal or curvilinear in nature in that it has one or more adjacent arcuate bends **1319** and **1320** in the shaft **1318**. The arcuate bends **1319**, **1320** have each have an apex **1321**, and the apexes **1321** are disposed on opposite sides of the driving shaft **1318**. A cam follower **1322** depends from a bottom surface **1323** of the second bristle holder **1310** and is disposed between the apexes **1321** of the cam **1316**. As the motor **819** of the enhanced toothbrush **810** rotates the shaft **1318**, a first surface **1325** of the cam **1316** comes into contact with a first surface **1324** of the cam follower **1322** and drives the cam follower **1322**, and therefore, the second bristle holder **1310** away from the first bristle holder **814** in a direction along the longitudinal axis **818** of the head portion **816**. As the shaft **918** continues to rotate, the apex **1321** passes and becomes disengaged with the first cam follower surface **1324**. A second surface **1326** of the cam **1316** then comes into contact with a second surface **1426** of the cam follower **1322** and the drives the cam follower **1322**, and therefore, the second bristle holder **1310** back toward the first bristle holder **814**. As this back and forth motion is repeated (as the shaft **918** continues to rotate), a scrubbing action is provided by the reciprocating or translating motion that is distinct from and complimentary to the motion provided by the first bristle holder **814**. The stroke and frequency of the reciprocating or translating motion can be varied by changing the spacing between the apexes and/or the amplitude, shape, or height of the apexes.

Referring to Figure 15, in a sixth embodiment of the enhanced toothbrush **810**, a second bristle holder **1508** is movably mounted to the toothbrush head **816** with a pivot **1510**, which can be provided in the form of a pin or hinge. The pivot **1510** is installed at a centrally located transverse axis of the second bristle holder **1508**. In one embodiment, the second bristle holder **1508** pivots about a pin, which is anchored in the sidewalls of

the toothbrush neck or head **816** at the midpoint of the second bristle holder **1508**. The second bristle holder **1508** is separately driven in a vibratory, swinging, teetering or rocking motion by a cam comprised of first **1512** and second **1514** cam portions included on a driving shaft **1518**. Optionally, the shaft is supported by shaft supports **1519**. The shaft supports may include C or U shaped portions (not shown) that are operative to receive and snap around the shaft. Other means for retaining a shaft in a support are known in the art. The cam portions **1512**, **1514** can comprise one or more rectilinear, curvilinear, or other bends in the shaft **1518**. As is illustrated in FIG. 15 the first cam portion **1512** is located adjacent a first side of the pivot and the second cam portion **1514** is located adjacent a second side of the pivot. The second cam portion **1514** can comprise a portion of the remote-most end or cam (not shown but similar to the remote-most end or cam **20** of FIG. 3) of the shaft **1518**. First **1520** and second **1522** cam contact surfaces are located on a bottom surface of the second bristle holder **1508**. As is the case with all the described embodiments, the amplitude or height of the bends or eccentricities that make up the first and second cam portions **1512**, **1514** are large enough reach the related cam contact surface(s) and to drive the second bristle holder a desired distance toward, into, across or along a toothbrush users teeth. Changing the distance between the apexes and the pivot point can vary the required amplitude or height. Changing the distance between the apexes and the pivot point may affect a required or desired torque delivered by the motor **819**. As the motor **819** of the enhanced toothbrush **810** rotates the shaft **1518**, the first cam portion **1512** comes into contact with the first cam contact surface **1520** and drives or lifts (relative to the figure) a first end **1522** of the second bristle holder **1510** causing the first end **1522** to rock or move about the pivot **1510** in a direction away from the head portion **816** and toward the teeth of a toothbrush user (not shown). This action lowers a second end **1526** of the second bristle holder back toward the head portion **816**. As the shaft **1518** continues to rotate, the first cam portion **1512** becomes disengaged with the first cam contact surface **1520** and the second cam portion **1514** engages the second cam contact surface **1522**. The second cam portion **1514** drives or lifts (relative to the figure) the second end **1526** of the second bristle holder **1508** causing the second end **1522** to rock or move about the pivot **1510** in a direction away from the head portion **816** and toward the teeth of the toothbrush user. This action lowers a first end **1530** of the second bristle holder back toward the head portion **816**. During use, as the first and

second cam portions **1512**, **1514** alternately come in contact with the first and second cam contact surfaces **1520**, **1522**, bristles of the second bristle holder **1508** are urged against teeth of the user with varying degrees of force. Preferably, bristles of the second bristle holder **1508** are urged between the teeth of the user to provide a cleaning and flossing function. As the rocking or pivoting motion is repeated (as the shaft **1518** continues to rotate), a flossing or deep cleaning motion is provided that is distinct from and complimentary to the motion provided by the first bristle holder **814**.

Referring to Figure 16, in a seventh embodiment of the enhanced toothbrush **810** a second bristle holder **1608** is movably mounted to the toothbrush head **816** with a pivot **1610**, which can be provided in the form of a pin or of a hinge installed at a transverse axis of the second bristle holder **1608**. In one embodiment, the second bristle holder **1608** pivots about a pin, which is anchored in the sidewalls of the toothbrush neck at the midpoint of the second bristle holder **1608**. The transverse axis is, for example, adjacent to a first end **1612** of the second bristle holder **1608**. The second bristle holder **1608** is separately driven in a vibratory, swinging, pivoting or rocking motion by a cam **1614** included on a driving shaft **1618**. Optionally, the shaft is supported by shaft supports **1619**. The shaft supports may include C or U shaped portions (not shown) that are operative to receive and snap around the shaft. Other means for retaining a shaft in a support are known in the art. The cam **1614** may be a portion of a remote-most end of the shaft **1618** (not shown but similar to the remote-most end or cam **20** of FIG. 3). The cam **1614** can comprise one or more bends in the shaft **1618**. For example, the bends can be rectilinear, curvilinear or other kinds of bends. A cam contact surface **1622** is located on a bottom surface of the second bristle holder **1608** adjacent to a second end **1626** thereof. As the motor **819** of the enhanced toothbrush **810** rotates the shaft **1618**, the cam **1614** comes into contact with the cam contact surface **1622** and drives or lifts (relative to the figure) the second end **1626** of the second bristle holder **1608** causing the second end **1626** of the second bristle holder **1608** to rock or move about the pivot **1610** in a direction away from the head portion **816** and toward the teeth of a toothbrush user (not shown). As the shaft **1618** continues to rotate, the cam **1614** becomes disengaged with the cam contact surface **1622**. During use, as the cam **1614** comes in contact with the cam contact surface **1622**, bristles of the second bristle holder **1608** are urged against teeth of the user with a varying degree of force. Preferably, bristles of the second bristle holder **1608** are

urged between the teeth of the user to provide a cleaning and flossing function. As the cam disengages with the contact surface **1622**, bristles pressing against the teeth of the user urge the second bristle holder away from the users teeth and back toward the head portion **816**. As this swinging or pivoting motion is repeated (as the shaft **1618** continues to rotate), a flossing or deep cleaning motion is provided that is distinct from, and complimentary to, the motion provided by the first bristle holder **814**.

Referring to FIG. 17 and FIG. 18, in a eighth embodiment of the enhanced toothbrush **810** a second bristle holder **1810** is movably mounted in slots **1812** in the toothbrush head **816** and separately driven in a reciprocating or translating, transverse motion within the slots **1812** by a cam **1816** included on a driving shaft **1818**. The cam **1816** can comprise an appropriately shaped bead placed over or molded and fixedly secured to the shaft **1818**. For example, the bead is shaped as and eccentric cam. Alternatively, the cam can include one or more rectilinear, curvilinear or other kind of bend. First **1822** and second **1826** cam followers depend from a bottom surface of the second bristle holder **1810**. The cam followers are, for example, offset from the longitudinal axis **818** of the second bristle holder and straddle or capture the cam **1816**. As the motor **819** (see FIG. 8) rotates the shaft **1818**, the cam **1816** comes into contact with a surface **1821** of the first cam follower **1822** and drives the first cam follower **1822**, and therefore, the second bristle holder **1810** away from a first side **1828** of the head portion **816** along a transverse axis **1830** of the head portion **816**. As the shaft **1818** continues to rotate, the cam **1816** becomes disengaged with the first cam follower **1822**. The cam **1816** then comes into contact with a surface **1825** of the second cam follower **1826** and drives the second cam follower **1826**, and therefore, the second bristle holder **1810** back toward the first side **1828** of the head portion **816**. As this back and forth or side to side motion is repeated (as the shaft **918** continues to rotate), a sweeping motion is provided that is distinct from and complimentary to the motion provided by the first bristle holder **814**.

Referring to FIG. 19 in a ninth embodiment of the enhanced toothbrush **810** a second bristle holder **1910** is movably mounted in slots (not shown) in the toothbrush head **816** and separately driven in an reciprocating or translating, longitudinal motion, by a cam **1916** included on a driving shaft **1918**. The cam **1916** can comprise a shaped bead, with an appropriate configuration, placed or molded over and firmly secured to the shaft

1918. The cam **1916** includes a reversing spiral or helical groove **1920**. The spiral or helical groove extends around a circumference of the bead and spirals about a longitudinal axis of the bead. For example, the longitudinal axis coincides with the shaft **1918**. A cam follower **1922** depends from a bottom surface **1923** of the second bristle holder **1910**. The cam follower **1922** is slidingly received within the spiral groove **1920**. As the motor **819** of the enhanced toothbrush **810** rotates the shaft **1918**, a first surface **1924** of the spiral groove **1920** comes into contact with a first surface **1925** of the cam follower **1922** and drives the cam follower **1922**, and therefore, the second bristle holder **1910** away from the first bristle holder **814** along the longitudinal axis **818** of the head portion **816**. As the shaft **1918** continues to rotate, the cam follower **1922** reaches an apex **1926** of the spiral groove **1920** and the first surface **1924** of the spiral groove **1920** becomes disengaged with the first cam surface **1925**. A second surface **1928** of the spiral groove **1920** then comes into contact with a second surface **1930** of the cam follower **1922** and drives the cam follower **1922**, and therefore, the second bristle holder **1910** back toward the first bristle holder **814**. As this back and forth motion is repeated (as the shaft **918** continues to rotate), a scrubbing motion is provided that is distinct from and complimentary to the motion provided by the first bristle holder **814**. Optionally cam **1916** is eccentrically mounted on the shaft **1918** and the longitudinal axis of the head or cam **1916** does not coincide with the shaft **1918**. In this case, if the cam follower **1922** is made long enough to ride on the bottom of the spiral groove **1920**, a lifting or vertical pulsing force is provided to the second bristle holder as the eccentrically mounted came is rotated by the shaft. Alternately, or additionally, the depth of the groove is varied. The variation in depth provides lifting or vertical pulsing forces to the cam follower and therefore to the second bristle holder. In either case, the second bristle holder is made to pulsate vertically in addition to the reciprocating or translating motion. The spiral groove may be replaced with a groove that cycles back and forth along the longitudinal axis of the bead several times as it circles the bead. This sort of groove can be used to increase the reciprocating frequency of the second bristle holder.

With the embodiments of the present invention have been illustrated for simplicity 30 with bristles, which extend in a direction substantially perpendicular to the longitudinal axis **818** and the surface (for example see **1115** of FIG. 11) of the bristle holders, it is contemplated that the bristles might be arranged differently to complement or further

enhance the motions of the first and/or second bristle holders. Referring to FIG. 20, some or all of the bristles might extend in a direction which forms an acute angle **2008** to a surface **2006** of the bristle holder and extends in a direction toward or away from the handle, such as shown by way of example in FIG. 20 with respect to bristles **2010** and **2014** respectively. Referring to FIG. 21, in another embodiment, some of the bristles might extend outwardly away from head, in another direction, again forming an acute angle **2108** with respect to the surface of the bristle holder, as shown by way of example in Fig. 21 with respect to bristles **2110** and **2114**. Massaging bristles or bristles of varying height might also be used, such as described in U.S. Patent Nos. Des. 330,286, Des. 434,563, the substances of which are incorporated herein by reference. Other preferred bristle arrangements suitable for use include those arrangements described in whole or part in U.S. Patents nos. 6,006,394; 4,081,876; 5,046,213; 5,335,389; 5,392,483; 5,446,940; 4,894,880; and international publication no. WO 99/23910; the substances of which are incorporated herein by reference.

The described embodiments have been described with certain words and phrases that attempt to describe certain motions. Motion can either be constant or vibratory. One example of a constant motion is simple rotation where an element angularly moves in a single direction (e.g., a bristle holder which only rotates clockwise or swivels clockwise in a cone like envelope) or translates in a single direction. Vibration is any periodic movement having repeated cycles. Vibratory motion can have one or more frequencies and amplitudes. Vibratory movement which is substantially linear is referred to herein as a reciprocating motion. Reciprocating motion can occur in a number of directions, such as substantially horizontal, substantially vertical (i.e., a lifting or pulsating motion), and combinations thereof. Vibratory movement which is substantially rotational in nature is referred to herein as an oscillatory or pivoting motion.

Because most motions can be complex in nature (i.e., include elements of other types of motion), the use of the above-described terms herein can include other motions, unless stated otherwise (e.g. reciprocates only), in addition to the basic or primary motion described by the term. So, for example, a motion which is described herein as reciprocating may also include other vibratory or constant movements even though the primary movement is reciprocatory in nature.

The invention has been described with reference to particular embodiments.

Modifications and alterations will occur to others upon reading and understandings this specification. For example, while certain have been described as comprising bends in a shaft and other cams have been described as including appropriately shaped beads secured to a shaft, the cams are not limited to the suggested form. Indeed, bends may be  
5 substituted for beads and beads may be substituted for bends. For example, FIG. 22 illustrates a tenth embodiment that is similar to the fifth embodiment illustrated in FIG. 13 and 14. However, in the tenth embodiment the cam **2216** is formed as an appropriately configured complex bead fixedly placed or co-molded over the shaft **2218**. The cam **2216** provides shapes **2218**, **2220** with surfaces that serve an equivalent purpose  
10 to the arcuate bends **1319**, **1320** described in reference to the fifth embodiment. Where first and second cam portions or surfaces are described or referenced, the portions or surfaces can be considered to be or implemented as separate cams. Where cams or cam portions are illustrated with one eccentricity or bent shape, multiple eccentricities or bent shapes may be included. Each added eccentricity or bent shape would increase the  
15 frequency with which the related bristle holder vibrates, pulses, pivots, swivels, rocks, oscillates, reciprocates or translates. Additionally, where multiple eccentricities are included, they may be of varying amplitude, thereby providing varying bristle holder movement amplitudes. It is intended that all such modifications and alternations are included insofar as they come within the scope of the appended claims or equivalents  
20 thereof.

All documents cited in the Detailed Description of the Invention are, in relevant part, incorporated herein by reference; the citation of any document is not to be construed as an admission that it is prior art with respect to the present invention.

While particular embodiments of the present invention have been illustrated and  
25 described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.